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# Observations on the Biology and Control of the Treehopper Heliria praealta (Fowler) in Orchards of the Pacific Northwest

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## INTRODUCTION

During the period 1929–34 studies were made in the Pacific Northwest on *Heliria praealta* (Fowler), a treehopper of the family Membracidae, which is of potential importance as a fruit pest. These studies were carried on chiefly in the Wenatchee, Wash., district. Other species of treehoppers found in orchards[1] had previously been studied by the senior author (*10*, *11*, *12*, *13*).[2]

## HISTORY OF THE INSECT IN THE WEST

This species was first found in the West in 1914 at Wenatchee, Wash., when E. J. Newcomer took it on apple. In 1915 Ball took it on apple at Logan, Utah, and in 1918 he (*1*) described it as *Heliria rubidella* from material from Fort Collins, Colo. The insect was first reported from the Yakima Valley of Washington by W. D.

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[1] Among the more common species found on orchard trees, all of which deposit their eggs there, are the following: *Ceresa albidosparsa* Stål., *C. basalis* Walk., *C. borealis* Fairm., *C. brevis* Walk., *C. bubalus* (F.), *C. femorata* Fairm., *C. taurina* (Fitch), *Stictocephala franciscana* (Stål.), *S. inermis* (F.), *S. pacifica* Van D., and *S. wickhami* Van D.

[2] Italic numbers in parentheses refer to Literature Cited, p. 12.

Whitcomb at Buena in 1919. It was observed in orchards in the Wenatchee district in 1928 (*14*) and was found there in great numbers by the senior writer in 1929. The same year one individual was taken by him near Selah, in the Yakima district, and others were taken by Claude Wakeland in orchards in the Parma, Mesa, and Fruitland districts in southern Idaho. This treehopper has been found in the Wenatchee district each year from 1928 to 1940.

## IMPORTANCE OF INJURY

This treehopper causes injury to fruit trees in two ways. Throughout its nymphal and adult life it feeds on the sap of the sprouts, twigs, and smaller branches of apple trees, utilizing nutrient materials that would otherwise be available to the tree. The adults in laying their eggs cause slight wounds in the bark, but these injuries are apparently of little importance.

The feeding and oviposition punctures may furnish points of entrance for the causative organism of the apple perennial canker (*Gloeosporium perennans* Zeller and Childs), although the few observations indicating such a possibility are too limited to be more than suggestive.

With its present abundance this treehopper is of secondary rank, but if favorable conditions should bring about a considerable increase in numbers it could assume a position of much greater importance.

## FOOD AND HOST PLANTS

In Montana, Colorado, and Utah *Heliria praealta* is found on chokecherry (*Prunus melanocarpa*), but in the Washington and Idaho section it has been found only on orchard trees (apple, pear, cherry, and prune), except in one instance, when it was taken by the senior writer on chokecherry sprouts growing at the base of an apple tree and in another when it was found on a poplar tree adjoining an orchard.

## DISTRIBUTION

In the original description (*5*) this species was said to have been taken at "Saguenay, Brazil," but Ball (*2*) has pointed out that the specimens were sent the Belgium Museum by Canon V. Huard, of Quebec, who formerly resided at Saguenay, a town on a river of that name, 100 miles or more northeast of Quebec. Barber (*3*) listed the species in 1914 from Florida, and Van Duzee (*9, p. 60*) in 1916 and Funkhouser (*6, p. 255*) in 1927 recorded it from Pennsylvania and Florida. Ball (*2*) stated in 1931, however, that the reference "from 'Pa,' was based on an example of *Telamona concava* and that from 'Fla.' on an example of *Telamona alta*." From the West it has been reported by Ball (*2*) from the following localities: Fort Collins, Veta Pass, Estes Park, and La Veta, Colo.; Bozeman and Helena, Mont.; Logan and Garland, Utah; and Buena and Wenatchee, Wash.

In the work here reported both the typical *Heliria praealta* and its variety *rubidella* have been encountered. Locality records not previously published are as follows: Wenatchee, Wash. (Newcomer);

Fruitland, Idaho (Haegele); Mesa and Parma, Idaho (Wakeland); Cashmere, Dryden, Entiat, Leavenworth, Monitor, Orondo, Peshastin, and Wenatchee (all in the Wenatchee district) (Yothers); and Selah, Wash. (near Yakima) (Yothers and Newcomer).

## SYNONYMY

This species was originally described by Fowler in 1894 as *Telamona praealta* (*5*). Ball (*1*) described material from Colorado as *rubidella*, placing his species in the genus *Heliria* Stål. Funkhouser (*6, p. 245*) in 1927 listed Ball's *rubidella* as a valid species. According to Ball (*2*), W. E. China, of the British Museum, examined material and reported that *praealta* "was undoubtedly the same *as rubidella*." Ball, however, considered *rubidella* as a variety of *praealta*.

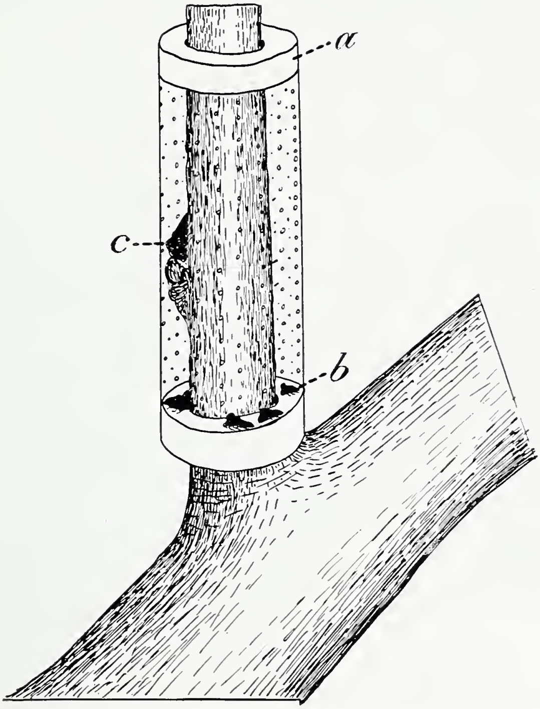


FIGURE 1.—Perforated cellophane cage for rearing individual treehopper nymphs on apple twigs: *a*, Rings of felt; *b*, molted skins; *c*, fifth instar in characteristic position behind a bud. × 1.

A series of specimens from the Pacific Northwest was examined in 1937 by P. W. Oman, of the Bureau of Entomology and Plant Quarantine, who found that the material included more specimens of the typical *praealta* than of *rubidella*, and it appeared that the distinction between the two forms was not very marked. The earlier name is therefore used in this paper. In much of the recent economic literature the form has been referred to as *Heliria rubidella* Ball (*11, 12, 13, 14*). *Buckton* (*4, p. 198*) examined Fowler's material and renamed the species *Telamona turritella*.

The more important synonymy is as follows:

*Telamona praealta* Fowler, 1894 (*5, p. 420*).
*Telamona turritella* Buckton, 1903 (*4, p. 198*).
*Heliria rubidella* Ball, 1918 (*1, p. 28*).
*Heliria praealta* Fowler, var. *rubidella* Ball, 1931 (*2, pp. 30, 31*).

## EXPERIMENTAL METHODS

In 1930 nymphs in the various stages were confined on the twigs by means of circles of sticky material. Sometimes the confined individuals escaped and sometimes nymphs from the outside got into the enclosed areas, but many individuals went through the entire nymphal development within the circles. Development was entirely normal, inasmuch as there was no influence on temperature, humidity, light, or any other factor. Since the individuals could not be observed often enough to keep up with their transformations and the molted skins were usually lost, it was not always possible to determine the exact time of molting or the instar.

In 1931 the nymphs were confined in cellophane cells surrounding the twigs (fig. 1). The ends of the cells were plugged with felt or cotton and the cellophane was well perforated with large pinholes to allow circulation of air. With this type of cage a complete series of molted skins was always available at the termination of the nymphal period.

Other stages were studied by miscellaneous observations.

## DESCRIPTION OF STAGES

### Egg

(Pl. 1, *I;* fig. 2)

About 1.5 to 2 mm. in length and 0.5 to 0.6 mm. in diameter. Roughly cylindrical, base bluntly rounded, tapering toward apex, margins slightly curved, white to pink in color, chorion vitreous, transparent.

### Nymph

Head compressed cephalocaudad, mouth parts reaching to third or fifth abdominal segment. Dorsum of second to seventh abdominal segments with blunt protuberances. Thorax and abdominal segments sparsely spined. Color white to pink when first hatched or molted, but within an hour or so turning to a mottled grayish brown, closely resembling the bark upon which the nymphs rest.

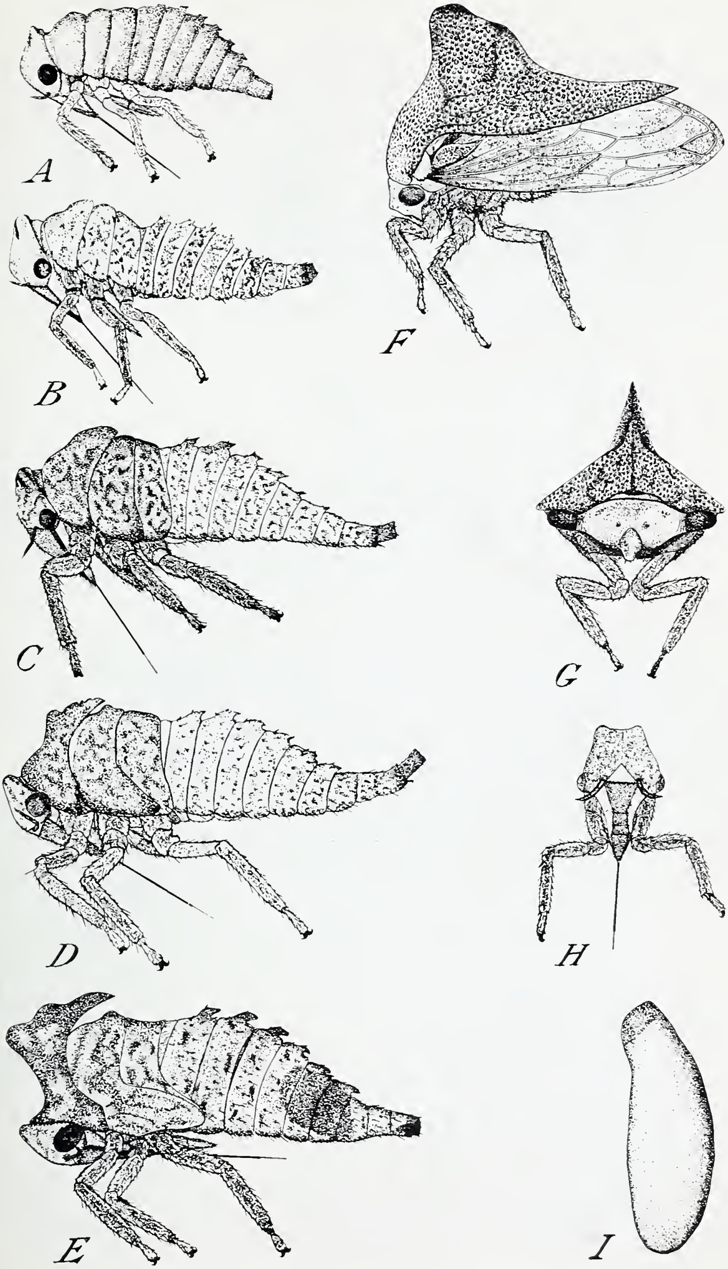
*First instar* (pl. 1, *A*).—Length 1.5 to 2 mm.

*Second instar* (pl. 1, *B* and *H*).—Length 2.75 to 3.25 mm. Median portion of pronotum prolonged posteriorly.

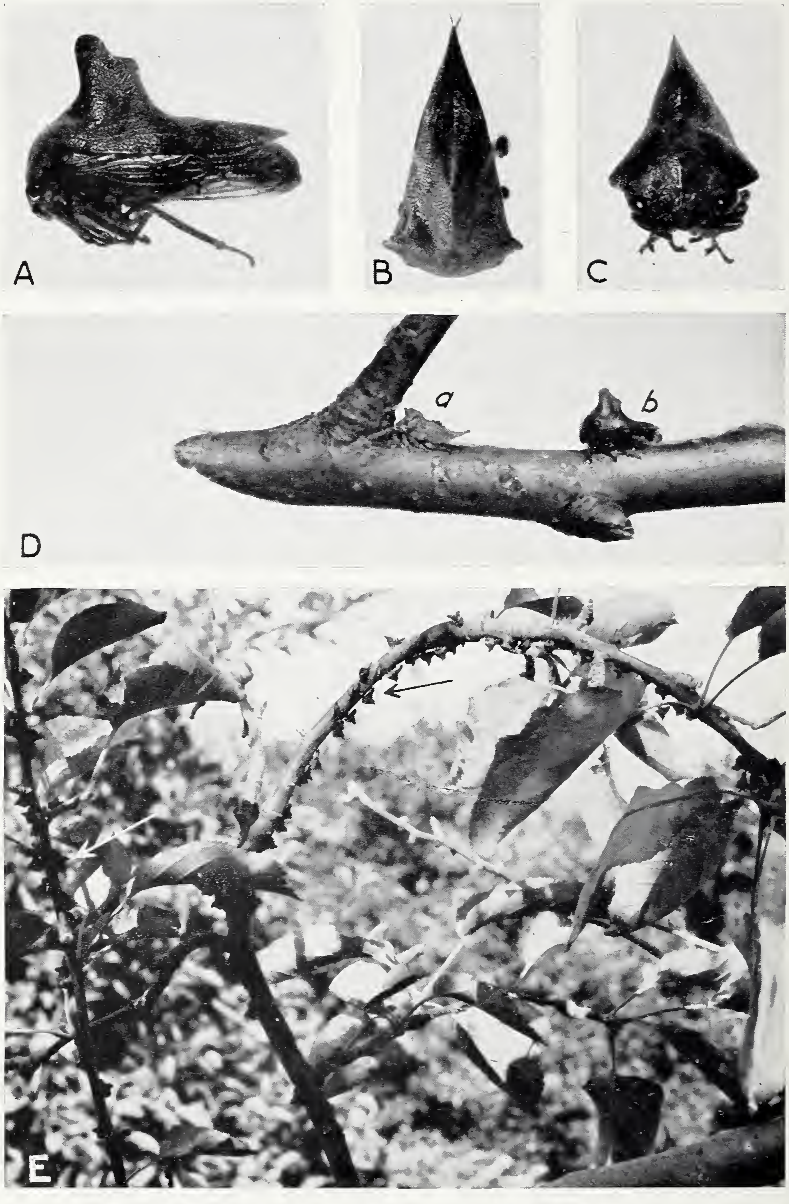
*Third instar* (pl. 1, *C*).—Length 3.75 to 4.25 mm. Median portion of pronotum much prolonged posteriorly, slightly curved distad indicating pronotal crest. Mesothorax slightly curved distad at base, forming rudimentary wing pads.

*Fourth instar* (pl. 1, *D*).—Length 4.75 to 5.25 mm. Dorsum of prothorax prolonged posteriorly to point, irregular in outline; wing pads conspicuous.

*Fifth instar* (pl. 1, *E*).—Length 6 to 7 mm. Dorsum of prothorax very irregular in outline, forming a distinct crest projecting posteriorly over mesothorax. Wing pads more pronounced, reaching to middle of third abdominal segment.



Stages in the development of *Heliria praealta:* *A*, First instar, side view, × 17; *B*, second instar, × 14; *C*, third instar, × 13; *D*, fourth instar, × 11; *E*, fifth instar, × 8; *F*, adult, side view, × 5; *G*, adult, front view, × 4; *H*, second instar, front view, × 12; *I*, egg, × 17.



*Heliria praealta:* *A*, Side view; *B*, dorsal view; *C*, frontal view; *D*, fifth instar (*a*) and adult (*b*); and *E*, characteristic group of adults on apple twig. *A*, *B*, and *C* × 4; *D* × 1¼; *E* × ¼.

## ADULT

(Pls. 1, *F* and *G;* 2, *A*, *B*, and *C*)

Fowler's original description of *praealta* (5) is as follows:

"Dark fuscous brown, with the central carina of the pronotum and sometimes apical portion of the dorsal protuberance black; pronotum strongly punctured with a very large and elevated dorsal protuberance; this is strongly declivous behind and in front, and in front is broadly sinuate before metopidium; its apex is broad, rounded and elevated in front, less high and with a straight

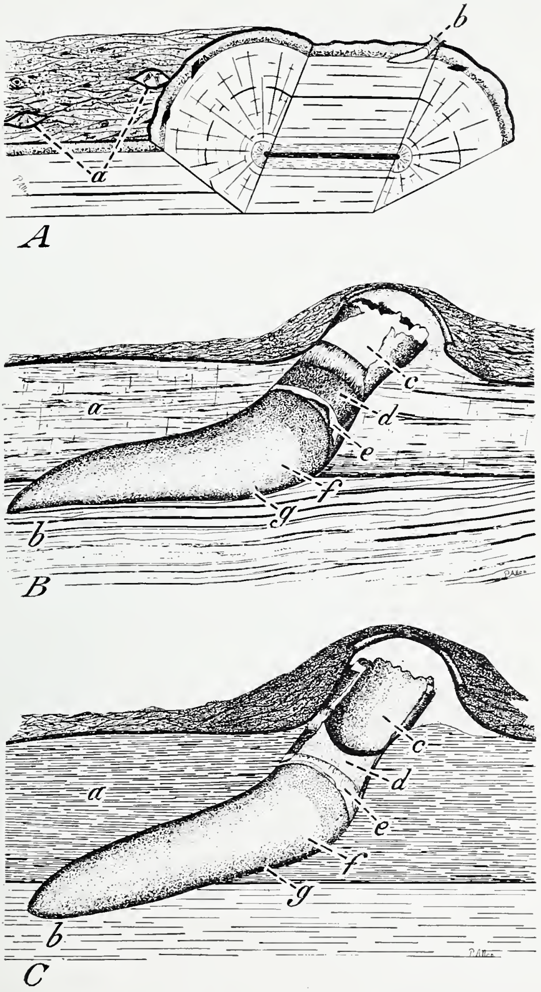


FIGURE 2.—Egg of *Heliria praealta: A*, Section of apple twig showing oviposition scars with exposed tips of two pairs of eggs (*a*) and longitudinal section through another egg (b), × 3.4. *B*, Egg exposed to show insertion through the bark (*a*) into outer cambium (*b*); also the micropyle (*c*), deutoplasmic plug (*d*), extension of vitelline membrane (*e*), vitelline membrane (*f*), and chorion (*g*), × 25. *C*, Longitudinal median section through an egg; parts as in *B*, × 25.

margin behind, and with the posterior angle obtusely rounded, but marked; tegmina hyaline externally, with the base and apex dark and the central portion smoky; underside and legs fuscous. Long. cum tegm. 9–10 mm.; lat., 5–6 mm."

Ball (*2*) separates the variety *rubidella* on the basis of paler color and broader crest.

The pronotal crest in this species is extremely variable, as indicated in plate 3 and figure 3.

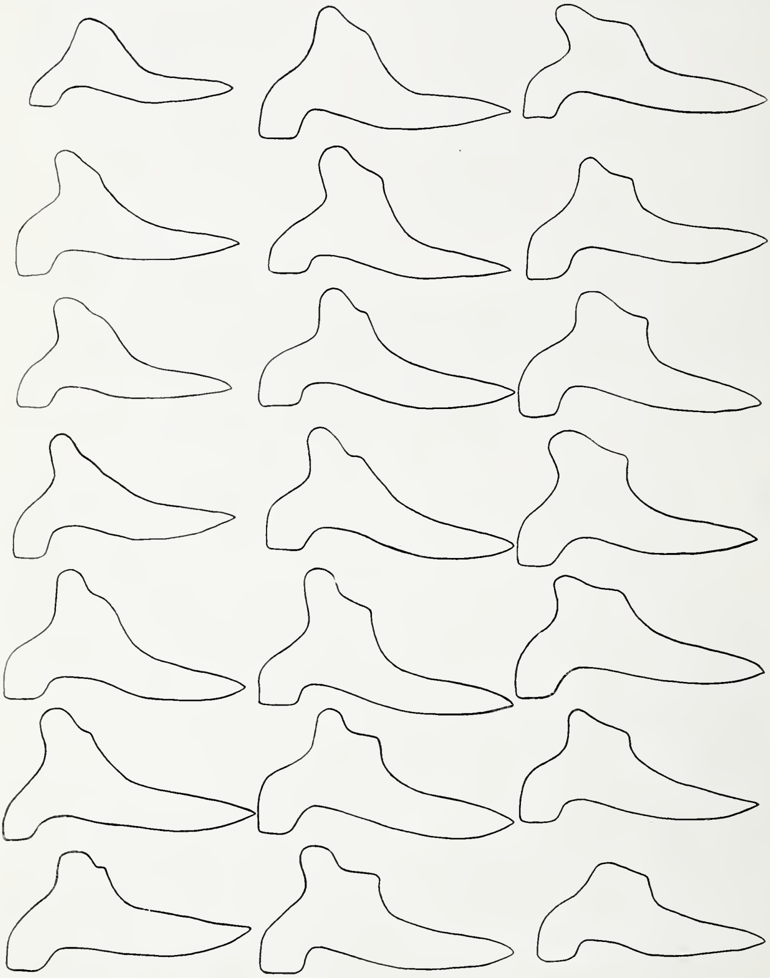


FIGURE 3.—Camera lucida outline drawings of pronotal crests of *Heliria praealta*, showing the wide variation in this character. All from Wenatchee, Wash. × 3½.

## LIFE HISTORY AND HABITS

Unlike the other membracids of the Pacific Northwest that have been studied, which feed on weeds or cover crops in the nymphal stages, *Heliria praealta* passes its entire life on the tree, in the bark of which the eggs are laid. Like the other species, however, it overwinters in the egg stage in the bark of a fruit tree. The eggs hatch late in April or early in May. By late May or early June most nymphs are in the last instar, and by the middle of June most individuals have become adults. The adults feed, mate, and oviposit on the trees, remaining there through the remainder of the summer. By September they are comparatively rare, but individuals have been found as late as October 4. There is but a single generation a year.

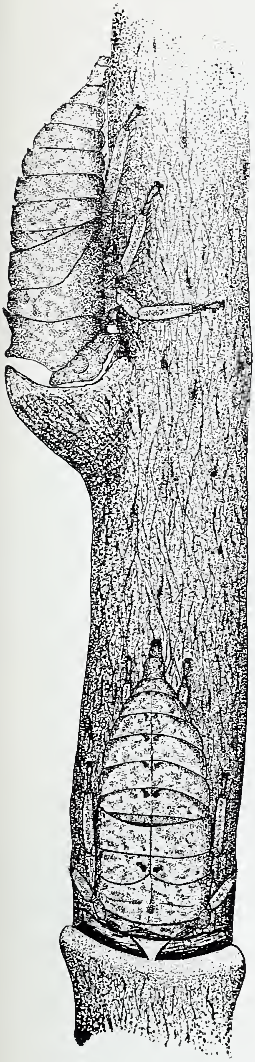


FIGURE 4.—Fourth instars feeding in characteristic position behind base of bud scars on apple twig. In this position the nymphs so nearly resemble buds as to be indistinguishable at a casual glance. × 9.

## NYMPHS

Hatching takes place for the most part during the forenoon between the hours of 8 and 11, usually on warm, humid mornings. The details of the hatching process were not observed minutely, but they are presumably characteristic of membracids in general (*13*).

Upon hatching, the nymphs settle nearby for feeding, usually in a protected spot close beside a bud or behind a bud scar where the bud has been removed (fig. 4). They continue to feed and pass through the five instars, sometimes without changing their position a great deal until they become adult. They may crawl upon the nearest bud, leaf, or leaf petiole to molt, but their movements are extremely limited.

*Heliria praealta* nymphs feed for the most part on 1- and 2-year-old wood and upon water sprouts of the current season growing from the trunk and scaffold limbs in the center of the trees. They are not limited to the younger wood, however, and have been found feeding on older limbs of as much as 2 inches in diameter. They generally feed upon the upper sides of twigs more or less horizontally located, usually with their heads directed downward or inward toward the center of the tree (pl. 2, *D* and *E*). While feeding, the nymphs are not readily disturbed and show little activity, except for short periods after molting. They are then very active and when approached may be seen quickly side-stepping around to the opposite side of a branch.

The nymphs are usually found singly, although they may be found in groups in the more suitable locations, such as at the bases of twigs and sprouts (pl. 4, *A*, *B*, and *C*), where considerable numbers of eggs are often laid.

During the entire nymphal period this insect shows considerable protective resemblance to the bark of the host and to the buds behind which it is very often found (fig. 1, *C*; pl. 4). In many instances, where the buds have been broken off, the nymphs are found in the position formerly occupied by the buds, and resembling them very closely. In this position they always feed with their broad head ends toward the bud scar (fig. 4).

The nymphs are also found singly or in groups about the wrinkled, grayish bark in crotches where sprouts or twigs grow from larger branches (pl. 4, *A*, *B*, and *C*).

Observations in 1930 and 1931 on the length of the nymphal stages are summarized in table 1.

Little information was obtained on the length of the first stage, since the first nymphs hatched sometime prior to the first observations. The molt into the second instar, however, was often observed, as were the other molts. The instar periods for 1930 are probably more characteristic than those for 1931, since they were determined under more nearly normal conditions.

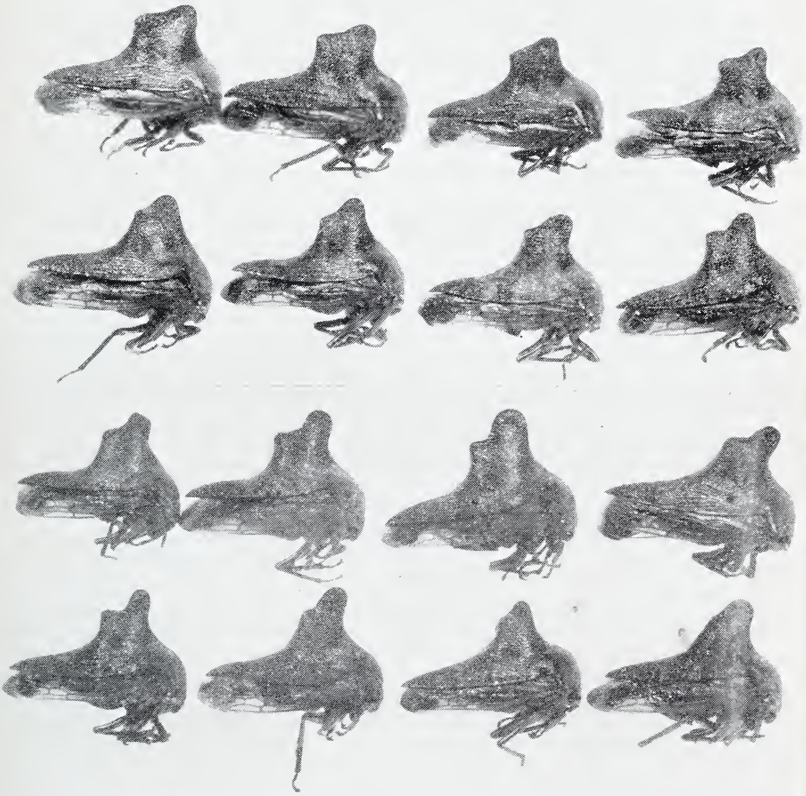
TABLE 1.—*Length of nymphal stages of Heliria praealta on apple twigs, Wenatchee, Wash., 1930–31*

| Year | Stage [1] | Individuals | Length of stage | | |
|---|---|---|---|---|---|
| | | | Minimum | Maximum | Average |
| | | *Number* | *Days* | *Days* | *Days* |
| 1930 | Second | 5 | 9 | 14 | 12.4 |
| | Third | 19 | 9 | 17 | 12.8 |
| | Fourth | 64 | 8 | 17 | 12.4 |
| | Fifth | 110 | 7 | 20 | 13.4 |
| | Average | | | | 12.7 |
| 1931 | Second | 19 | 4 | 11 | 7.8 |
| | Third | 13 | 5 | 12 | 7.0 |
| | Fourth | 18 | 9 | 16 | 11.5 |
| | Fifth | 18 | 10 | 15 | 12.4 |
| | Average | | | | 9.7 |

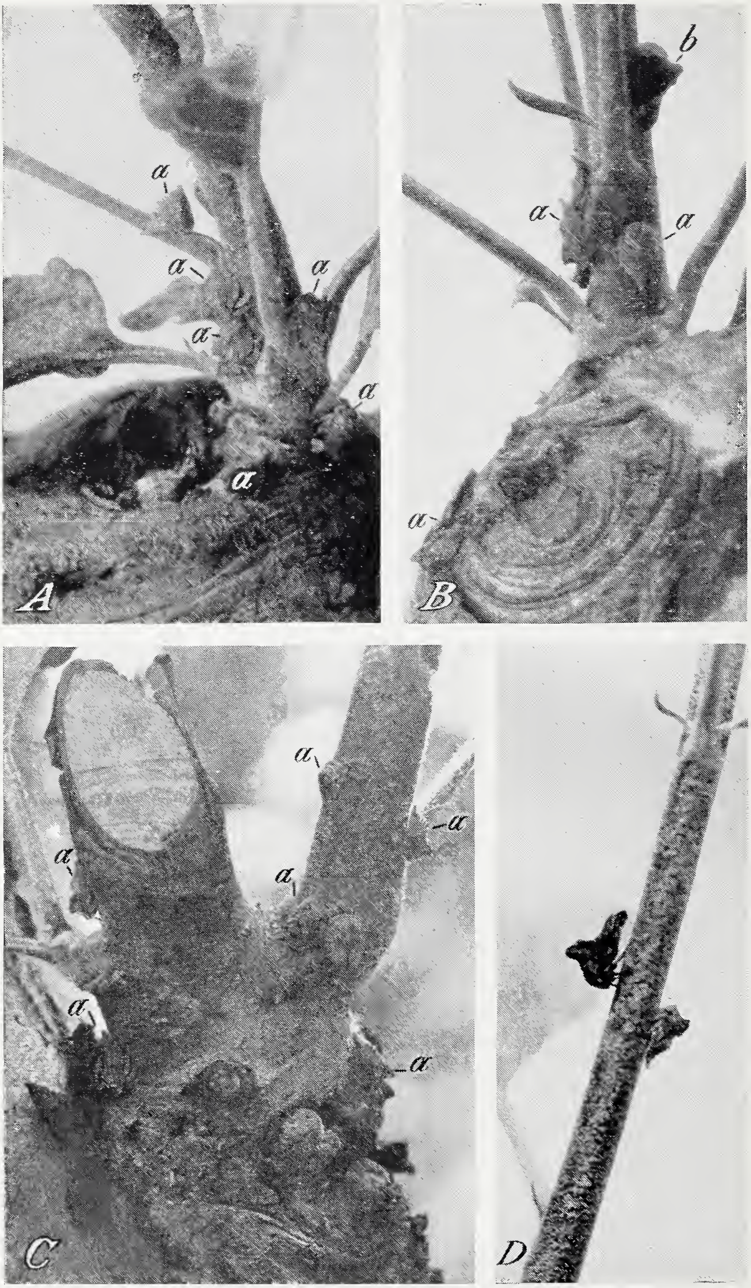
[1] No data obtained on first stage.

The molts are all much alike and the process is similar to that of other species of membracids described by the senior author (*11*, *13*). Molting, like hatching, usually takes place in the early forenoon while the humidity is high and the temperature low. When the air is dry, the skin does not split so readily and the molting is not only retarded but in some cases stopped entirely, and the insect dies without completing its transformation. If it is able to emerge after an unusual delay, it is likely to be deformed and abnormal. This often results in abnormal pronotal crests, some of which are so bizarre that they bear little resemblance to the typical crest. For this reason it is not surprising that there is so much variation in this character within a given species (pl. 3; fig. 3).

Like most other membracids the nymphs of *Heliria praealta* produce honeydew, which is everywhere evident as wet spots on the branches and trunks of trees wherever the nymphs are present in any numbers. One often sees tiny showers of the glistening drops of honeydew excretion falling through the air. Several drops are expelled in rapid succession, reminding one of pistol shots. They are shot far away and free from the insect's body and its immediate vicinity, usually preventing contamination of the insect itself. A group of three or four nymphs are capable of causing a sticky, wet spot several inches



Pronotal crests of *Heliria praealta*, showing variation among individuals. All from Wenatchee, Wash. × 2.7.



Nymphs and adults of *Heliria praealta* on or near base of water sprouts on apple tree: *A*, *B*, and *C*, fourth and fifth instars (*a*) and adult (*b*), × 1.3; *D*, adult and fifth instar, × 1.2.

Dying branch of Stayman Winesap apple tree at Wenatchee, Wash., characteristic of type of tree infested by *Heliria praealta* adults.

in diameter on the bark below. Sometimes the droplets are expelled in such a direction that they combine to form sizable drops on the surface of the leaves.

Wherever honeydew is present on the bark and foliage, or whenever groups of nymphs are expelling this fluid, ants are found in numbers attending the nymphs and feeding on the voided droplets. At least one species of ant has often been seen carrying first and second instars just as they do aphids. They have also been observed stroking the nymphs with their antennae, whereupon the nymphs expelled the honeydew, which was at once eaten by the attending ants.

## Adults

The adults as well as the nymphs feed on the sap of the host apple trees. They do not appear to favor any protected position, such as behind buds or bud scars, as do the nymphs. They do, however, exhibit a peculiar habit of grouping themselves in rows on the undersides of dying apple branches and remaining for hours, usually headed downward or inward toward the tree trunk (pl. 2, *E*). This habit is particularly noticeable on the Stayman variety, which in the Wenatchee area has a tendency to die limb by limb of a heart rot which affects the large scaffold branches (pl. 5). On these dying limbs hundreds of adults of *Heliria praealta* congregate and feed on the sap, which doubtless has an unusual attraction for them. This attraction seems to cease when the branches become dry. The insects tend to congregate on the limbs just preceding and during a shower. So far as is known, the adults do not deposit their eggs in these dying branches. No eggs have been found in them and no nymphs have ever been taken on them the following season.

This habit led at first to the erroneous assumption that the treehoppers were causing the branches to die, but observations soon indicated that their presence in such situations was in no way responsible for this condition.

In 1930 a number of adults of *Heliria praealta* were captured in sticky bands placed on the trunks of apple trees in connection with studies on the woolly apple aphid. Since they are rarely found on the trunks, their presence in the sticky bands suggests that the material may have been attractive to them.

## Oviposition and the Eggs

Oviposition occurs for the most part during July and August. The eggs are deposited in groups of two (fig. 2, *A*, *a*) in the bark of the younger wood, usually at the base of water sprouts and in 1- to 3-year-old twigs. The outer openings of the oviposition wounds may easily be mistaken for lenticel openings. The outer tips of the two eggs are close together near the surface and the inner ends widely divergent, forming an inverted V, with the arms well imbedded through the bark and into the cambium (*a* and *b* in fig. 2, *B* and *C*). The micropyle in this case has been extended into a neck, within which is found a deutoplasmic plug (*d* in fig. 2, *B* and *C*). Here the plug has been slightly pushed up to show how the vitelline membrane extends upward to form the base of the plug. The plug doubtless serves to protect the egg against any outside adverse influence, including certain predaceous enemies.

## SEASONAL HISTORY

Ordinarily hatching begins late in April, adults first appear the last of May or the first of June, the earliest mating occurs after the middle of June, and adults may be found as late as the first of October.

Complete data on seasonal variations in the biology of the insect were not obtained, but observations made at Wenatchee during the years 1930–34 are presented in table 2.

TABLE 2.—*Observations on the seasonal history of Heliria praealta at Wenatchee, Wash., 1930–34*

| Year | First hatching | First adults observed | First mating | Last adults observed |
|---|---|---|---|---|
| 1930 | Apr. 28 | June 3 | June 26 | Oct. 4 |
| 1931 | Apr. 29 | June 2 | June 19 | Oct. 1 |
| 1932 | Apr. 30 | May 27 | June 20 | Sept. 30 |
| 1933 | Apr. 26 | June 15 | July 12 | Oct. 2 |
| 1934 [1] | Apr. 10 | May 22 | June 12 | Oct. 1 |

[1] The spring season of 1934 was the earliest in 22 or more years.

## DISSEMINATION

Long-distance dissemination of this insect undoubtedly occurs chiefly in the egg stage in nursery stock. The adults are capable of flight and may be seen flying short distances, as from one limb to another or from one tree to the next or another not far away. Some of them doubtless fly some little distance, since hundreds are often assembled on the dying branches of sick trees, and such numbers do not originate on any one tree. The nymphs of this species do not travel or move about much, but usually remain at about the same spot throughout the nymphal period.

## PREDACEOUS ENEMIES

When the eggs of *Heliria praealta* are hatching and the emerging nymphs are still attached to the hatching membrane, and later when the earlier stages are molting, a species of spider, apparently *Dendryphantes militaris* Hentz, is often seen devouring these stages. This species has been recorded as attacking other treehopper eggs and young nymphs (*13*). In a cage in which nymphs were confined, one of these spiders was found to have killed several nymphs and to be eating a third instar when observed.

## CONTROL MEASURES

Because of the secondary importance of this pest no systematic experimentation with control measures has been carried on. A few suggestions will be made, however, chiefly on the basis of observations.

Sprays of lubricating-oil emulsion at a strength of 4 percent applied during the dormant period apparently have considerable value in the control of this treehopper. In 1931 a severe infestation in an orchard near Wenatchee nearly disappeared following the application of an oil spray while the trees were dormant. Previous applications of dormant-strength lime sulfur (approximately 4° Baumé) in this orchard and in other orchards that year apparently had little or no effect on the insects. In the first orchard eggs which had been laid in water sprouts in an apple tree, and which were protected by a cheesecloth cage used for biological work, appeared to be unaffected by the oil spray and hatched in considerable numbers. Few hatched elsewhere on the tree, although the insect had been moderately abundant all over the tree the preceding season. Harman (*7*) reports killing 75 percent of the eggs of *Glossonotus crataegi* (Fitch), a similar species, with an emulsion containing 6 percent of oil.

In an orchard at Wenatchee an application of summer-oil emulsion (approximately 83 percent of oil) in 0.75 percent concentration gave no control of the fourth and fifth instars of *Heliria praealta*, but it might have some value against the earlier instars. Although not tested by the writer, nicotine, or nicotine and oil, as sometimes used for codling moth control, should give some control of the nymphs of this species, especially if applied when the insects are in the earlier instars. Hutson (*8*), in Michigan, found that 1 gallon of summer-oil emulsion plus ½ of a pint of nicotine sulfate in 100 gallons of water, as well as ½ of a pint of nicotine sulfate plus ½ of a gallon of a commercial activator to 100 gallons, gave approximately 100 percent control of *Glossonotus crataegi* in the nymphal stage. Nicotine, derris, and pyrethrum dusts had no effect, according to Hutson.

Since many of the eggs are deposited in the water sprouts growing in the center of the trees, these should be removed at pruning time, and the cutting should be done as close to the trunk or scaffold limbs as possible. Some of the eggs are deposited in the twigs and larger branches, however, which cannot be pruned off. Pruned sprouts and twigs should be burned before time for hatching of the eggs, although not many eggs will hatch in detached pieces.

Since great numbers of the adults habitually congregate on sick and dying tree branches, it might be feasible to apply an adhesive to capture these adults. In case the commercial adhesive proved conflicting with the attractive odor of the dying branch, thereby proving a deterrent, an odorless adhesive could probably be substituted.

## SUMMARY

Observations on the biology and control of the treehopper *Heliria praealta* (Fowler) were made near Wenatchee, Wash., during the period 1929–34. This insect was found in some numbers in orchards in the Pacific Northwest in 1928, 1929, and subsequently, but at present is considered of only secondary importance.

In the Wenatchee district the insect feeds upon and oviposits in the apple tree almost exclusively. It has been found rarely on cherry, pear, prune, poplar, and in one case on wild chokecherry.

The eggs are deposited in the branches and twigs, and the nymphs remain throughout their nymphal and adult life upon the trees, where they feed, mate, and deposit their eggs.

There is but one generation a year. The eggs hatch in late April and early May. The nymphs pass through five instars, reaching maturity in about 40 to 50 days, usually about the first of June. Oviposition occurs throughout July and August. Adults are usually present from the last of May to the first of October, although they are rare after early September.

The adults' habit of congregating by hundreds on the dying limbs of apple trees, particularly the Stayman Winesap variety affected with heart rot, is very pronounced.

The use of oil-emulsion sprays while the trees are dormant, as applied in general orchard practice, is probably an effective control measure against the overwintering eggs in the bark. Lime sulfur is apparently not effective as an ovicide against this insect. Summer-oil emulsions, nicotine sprays, or oil emulsion and nicotine, against the early nymphal stages, as are used sometimes in codling moth control, should prove effective.

Pruning out of water sprouts in the center of the trees and destroying them before the eggs hatch in the spring, and the use of adhesives to trap the adults, especially on the dying branches where the adults congregate, may prove of value as control measures.

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